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CATALOGUE OF DATA ON URANIUM INTAKE, ORGAN BURDEN AND EXCRETION

by

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A research report prepared for the
Atomic Energy Control Board
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Canada

Research report

CATALOGUE OF DATA ON URANIUM INTAKE, ORGAN BURDEN AND EXCRETION

ABSTRACT

The Atomic Energy Control Board is initiating the critical evaluation of current biokinetic and dosimetric models applicable to radiation workers exposed to the common chemical and physical forms of uranium that are encountered throughout the nuclear fuel cycle. The identification and location of the relevant sets of data are the first steps of this project. This report describes the collection methods used and presents catalogues of the data on human and animal studies that have resulted from exposures under controlled experimental conditions, chronic occupational or environmental situations and acute accidental conditions. The data was identified through the use of computerized literature searches of the BIOSIS, NTIS, MEDLINE and Occupational Safety and Health (NIOSH) data bases, library research and telephone contact with currently active researchers in the field. A table is presented which categorizes researchers in the field according to affiliation and country.

RÉSUMÉ

La Commission de contrôle de l'énergie atomique a entrepris une évaluation critique des modèles biocinétiques et dosimétriques applicables aux travailleurs sous rayonnements exposés aux composés de l'uranium couramment présents dans le cycle du combustible nucléaire. Les premières étapes de ce projet ont été l'identification et la localisation des ensembles de résultats pertinents. Le rapport décrit les méthodes utilisées pour collecter les informations et contient le catalogue des résultats obtenus chez l'homme et l'animal à la suite d'expositions expérimentales contrôlées, d'expositions professionnelles chroniques, ou d'expositions aiguës accidentelles. Les ensembles de résultats ont été identifiés au cours de recherches bibliographiques dans les banques de données BIOSIS, MEDLINE et "Occupational Health and Safety (NIOSH)", dans les bibliothèques, et par contact téléphonique avec les chercheurs actifs dans ce domaine. Une liste de ces chercheurs par spécialité et nationalité est donnée dans un tableau séparé.

DICLAIMER

The Atomic Energy Control Board is not responsible for the accuracy of the statements made or opinions expressed in this publication and neither the Board nor the author assumes liability with respect to any damage or loss incurred as a result of the use made of the information contained in this publication.

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1.0 INTRODUCTION

The Atomic Energy Control Board (AECB) is initiating the critical evaluation of current biokinetic and dosimetric models applicable to radiation workers exposed to the common chemical and physical forms of uranium that are encountered throughout the nuclear fuel cycle. This undertaking will consist of:

a) critically reviewing the existing sets of data on uranium intake (or exposure), organ burden and excretion; and

b) critically reviewing and testing current biokinetic and dosimetric models for uranium

The identification and location of the relevant sets of data are the first steps of this project and are described here.

The objective of this project is to provide the AECB with a catalogue of the existing sets of data on uranium intake (or exposure), organ burden and excretion. The scope of work required that the data sets be identified, located and listed with a succinct description of their content.

The objective of this project was achieved through the use of computerized literature searches, library research and telephone contact with currently active researchers in the field.

In Chapter 2, the overall approach to data collection has been described. The methodology used to search computerized data bases and to identify other library references is explained. A number of currently active researchers in the field have been contacted and identified for future reference. The characteristics of the literature summaries are described and a quality assurance program is detailed.

In Chapter 3, one page descriptions of each of the identified references

relating to human data are presented alphabetically by author.

In Chapter 4, one page descriptions of each of the identified references relating to animal data are presented alphabetically by author.

Finally, the reference list for both human and animal data is given.

2.0 DATA COLLECTION METHODOLOGY

Sources of uranium bioassay data on man and animals were located through the use of a computerized literature search, study of the reference list in several major review articles and reports published by experts in the field and finally by contacting active researchers.

The computerized literature search was carried out on the four data bases BIOSIS Reviews, NTIS, MEDLINE and Occupational Health and Safety (NIOSH). The data bases are described in Table 1 and include references from as early as 1964 and as current as 1986 and 1987. Many different disciplines are represented such as life sciences, biomedical sciences and occupational health and safety. The references in the data bases are drawn from international periodical literature, books, technical reports and reports of research development and engineering projects sponsored by government agencies.

Numerous review articles, books and conference proceedings, listed in Table 2, were identified as major sources of information for this study. The reference lists of these documents identified many publications of original research and investigations related to either human or animal bioassay for uranium. Applicable publications were added to the references in the last section of this report.

Another fruitful means of identifying applicable data for this report was to contact by telephone numerous researchers active in the field. The names and affiliations of those contacted are given in Table 3. All of the researchers were most helpful in identifying sources of bioassay data and provided reports describing their recent work. This was not indicated in the table. However, entries in Table 3 have been included where researchers indicated that the results of current or soon to be completed work will be available. This information will be useful during the next stage of this project.

By the means described above, a list of reports was compiled that addressed uptake, retention and/or excretion of uranium by man or animals. No attempt

to judge the accuracy, validity or suitability of any of the results was made. The assessment of the data falls within the scope of the next stage of the project. The list of references has been given in the last section of this report and includes the title of the report, the author(s) name, date of publication and journal proceedings or book reference.

When it was possible to obtain copies and study the text (or abstracts) of these reports succinct descriptions were prepared. The report summaries were divided into two groups - summaries of human data are included in Chapter 3 and summaries of animal data are included in Chapter 4.

The summaries of human data include: the author(s) name(s); the title of the report; the publication containing the report; the author(s) affiliation; the number and sex of the subject(s); the type of exposure - accidental, occupational or controlled experiment; the administration - inhalation, ingestion or dermal; the chemical form; the dosage or exposure; the duration of exposure; the follow-up period; and indication of in-vivo, post mortem tissue, urine, fecal or other analysis. In cases where the data were assembled from secondary sources (another article, book, or abstract), a note was added to the comments category indicating the secondary source(s). If no description of data analysis was reported in an article, it was considered not performed. And where information concerning other categories such as duration of exposure was not found, it was indicated by N/A (not available).

The summaries of animal data are similar with the exception that the entry, post mortem tissue analysis, was changed to sacrifice and tissue analysis.

Three participants were involved in the preparation of this report and the summaries in Chapters 3 and 4. In order to ensure consistency and accuracy, the following quality assurance test was carried out.

Independently, the three participants completed summary sheets on two reports identified from the reference list. The results of this test are given in Tables 4a and 4b. Although there was considerable difference in the level of

detail in the responses, the accuracy one should expect is well illustrated by the similarities in the summaries.

Before 1940, there was limited research into the behaviour of uranium in man and animals. During and since the nuclear weapons development projects in the early forties, efforts have been focussed on the need to understand the behaviour of uranium for the purposes of estimating chemical and radiological damage to man. The reports of this research listed in the last section of this report total 166 and originate from several centres of research. The authors' names have been sorted according to affiliation and the results are presented by country in Table 5.

Table 1

DATA BASES SEARCHED

	BIOSIS	NTIS	MEDLINE	Occupational Safety and Health (NIOSH)
Time Period Covered	1969 to 1987 (Feb.)	1964 to 1987	1980 to 1987 (Mar.)	1973 to 1986 (Sept.)
Description	covers the major publications of Biosciences Information Service, comprehensive world-wide coverage of research in the life sciences	produced by the National Technical Information Service of the U.S. Department of Commerce	produced by the U.S. National Library of Medicine and covers biomedical literature materials	produced by U.S. National Institute for Occupational Safety and Health
Sources	periodical literature, monographs, books, technical reports, meetings, etc.	the database consists of government-sponsored research, development and engineering reports of 3 major U.S. federal government agencies: U.S. Dept. of Energy U.S. Dept. of Defence National Aeronautics and Space Administration plus many other agencies	Medline indexes articles from approximately 3200 journals in over 70 countries	covers 1) 150 current journals in health and safety and related fields 2) all NIOSH publications

Table 2

MAJOR REVIEW ARTICLES AND CONFERENCE PROCEEDINGS

URANIUM, Chapter 68 in HANDBOOK ON THE TOXICITY OF INORGANIC COMPOUNDS, by D. Fisher, Ed. Seiler, H.G. and Sigel, H. 1987, Marcel Dekker Inc., New York

BIOKINETICS AND ANALYSIS OF URANIUM IN MAN, Proceedings of a Colloquium held at Richland, Washington, 8-9 August, 1984, Ed. R.H. Moore, United States Uranium Registry, USUR-05 HEHF-47

THE CHEMICAL TOXICITY OF URANIUM WITH SPECIAL REFERENCE TO EFFECTS ON THE KIDNEY AND THE USE OF URINE FOR BIOLOGICAL MONITORING, G.J. Stopps and M.Todd, Atomic Energy Control Board, 1982, INFO-0074

LIMITS FOR INTAKES OF RADIONUCLIDES BY WORKERS, ICRP 30, Part 1, 1978, International Commission on Radiological Protection, Pergamon Press

CONFERENCE ON OCCUPATIONAL HEALTH EXPERIENCE WITH URANIUM, At Arlington, Virginia, 28-30 April, 1975, Ed. M. E. Wrenn, U.S. Energy Research and Development Administration, ERDA-93

APPLICATION OF BIOASSAY FOR URANIUM, R.E. Alexander, 1974, U.S. Atomic Energy Commission, WASH-1251

KIDNEY AND BONE RETENTION FUNCTIONS IN THE HUMAN METABOLISM OF URANIUM. Adams, N.A. and Spoor, N.L., 1974, Phys. Med. Biol., vol 19, pp 460-471

ASSESSMENT OF URANIUM AND PLUTONIUM BODY BURDENS, Konig, L.A. and Schieferdecker, H. in Atomic Energy Review, 1974, Vol. 12 pp. 343-418

URANIUM, PLUTONIUM, TRANSPLUTONIC ELEMENTS. HANDBOOK OF EXPERIMENTAL PHARMACOLOGY VOL. 36, Ed. Hodge, H.D., Stannard, J.N. and Hursh, J.B., 1973, Springer-Verlag

EVALUATION OF RADIATION DOSES TO BODY TISSUES FROM INTERNAL CONTAMINATION DUE TO OCCUPATIONAL EXPOSURE, ICRP 10, 1967, International Commission on Radiological Protection, Pergamon Press

DEPOSITION AND RETENTION MODELS FOR INTERNAL DOSIMETRY OF THE HUMAN RESPIRATORY TRACT, Task Group on Lung Dynamics, 1966, Health Physics, Vol. 12, pp. 173-207.

THE ESTIMATION OF INTERNAL RADIATION DOSE FROM METABOLIC AND URINARY EXCRETION DATA FOR A NUMBER OF IMPORTANT RADIONUCLIDES, Jackson S. and Dolphin G. W., Health Physics, 1966, Vol. 12 pp. 481-500

INHALED PARTICLES AND VAPOURS, Ed. C.N. Davies, Proc. of Int. Symp. 29 March - 1 April 1960, Permagon Press

HUMAN DATA ON URANIUM EXPOSURE, Sym. on Occupational Health Experience and Practices in the Uranium Industry - HASL-58, Ed. A. Butterworth, 1959

Table 2, continued.

TOXICOLOGY OF URANIUM, Ed. A. Tannenbaum, 1951, McGraw-Hill Book Company

PHARMACOLOGY AND TOXICOLOGY OF URANIUM COMPOUNDS, Ed. Voegtlin, C. and Hodge, H.C., 1949, McGraw-Hill Book Company

Table 3

CONTACTS AND AFFILIATIONS

Dr. John Johnson
Atomic Energy of Canada Limited,
Chalk River, Ontario
Tel. 613-687-5581

Dr. Bhawani Pathak
Canadian Centre for Occupational Health and Safety,
250 Main Street East
Hamilton, Ontario
L8N 1H6
Tel. 416-572-2981

Dr. Darrell Fisher
Battelle Pacific Northwest Lab.,
P.O. Box 999
Richland, Washington
Tel. 509-375-6852

Dr. Fred T. Cross
Battelle Pacific Northwest Lab.,
P.O. Box 999
Richland, Washington
Tel. 509-375-2976

Dr. Jerry B. Hunt
Oak Ridge National Laboratory
P.O. Box Y
Oak Ridge, Tennessee
Te. 615-574-3547

He indicated that unpublished bioassay data for uranium workers is on file at ORNL. In the near future, (7 to 20 years), five retired workers will be remeasured for uranium burdens and excretion rate.

Dr. McDonald E. Wrenn
Radiobiology Division
University of Utah
Salt Lake City, Utah, 84112
Tel. 801-581-5917

Dr. James Lawrence
Los Alamos National Laboratory
Los Alamos, New Mexico, 87545
Tel. 505-667-8081

Dr. H.D. Beiter
University of Rochester
Rochester, New York, 14642
Tel. 716-275-3862

Dr. Paul Morrow (716-275-3861) has recently completed another experiment that is being written up.

Table 3, continued.

Dr. Ronald Kathren United States Uranium Registry P.O. Box 100 Richland, Washington, 99352 Tel. 509-375-2132	Indicated that two reports would be of great value but are not yet published. a) DOE conference on Uranium in Nov. 1985, will include some human data that has never before been published b) Nuclear Regulatory Commission report of first human pathology data from Dec. 1985
Dr. John Ballou Battelle Pacific Northwest Lab Battelle Boulevard PO Box 999 Richland, Washington, 99352 Tel. 509-376-0900	
Dr. John Bromley Environmental and Medical Sciences Division (Biology) Builing 551, AERE Harwell Oxfordshire, OX11 ORA Tel. Abingdon 235 24141 Ext. 4795	(He reported that Dr. H. Smith is responsible for the uranium bioassay work. Also, Dr. John Halcon Tel. 235 831600
Dr. A. Gilman Bureau ofChemical Hazards Health and Welfare Canada Ottawa, Ontario Tel. 613-957-1876	Described recent experiments with rabbits and rats, to be published
Dr. R.E. Alexander Nuclear Regulatory Commission Washington, D C Tel. 301-443-7976	
Dr. Edwin Still Kerr-McGee Corporation P.O. Box 25861 Oaklahoma City, Oaklahoma, 73125 Tel. 405-270-2934	Reported that he and Dr. Wrenn of the University of Utah would be publishing a paper on recent data for Kerr-McGee Sequoyah Plant Workers. The follow up of these workers is continuing.

Table 4.a

COMPARISON OF CATALOGUING BY THREE RESEARCHERS

Author(s)	Bernard, S.R.		
Title	Maximum Permissible Amounts of Natural Uranium in the Body, Air and Drinking Water Based on Human Experimental Data		
Publication	Health Physics, 1958, Vol. 1, pp. 288-305		
Authors' Affiliation	Oak Ridge National Laboratory		
Subject of Study	8 terminal patients	8 humans (terminal brain tumours)	8 terminally ill brain tumour patients
Type of Exposure	controlled	Controlled	Controlled
Administration	intravenous injection	Intravenous injection	Intravenous injection
Chemical form	6 : hexavalent uranium 2 : tetravalent uranium	(6) hexavalent and (2) tetravalent forms of uranium	Prepared solutions of (1) hexavalent U (2) tetravalent U (as uranium tetrachloride)
Dosage/Exposure	4-50 mg of uranium	4-50 mg U	4 to 50 mg of uranium
Duration of Exposure	one injection	Bolus injection	Instantaneous (by injection)
Follow-up Period	to death (25 - 556 days)	Up to 556 days	Up to death (from previous brain tumours) on 140 days
In Vivo Measurement	no	No	
Postmortem Tissue Analysis	yes	Yes	U analysis (for tetra and hexa U) in bones, kidneys, liver, and several other tissues
Urine analysis	yes	Yes	Yes, measured U excreted as function of time
Fecal analysis	yes	No	Yes, measured U excreted as function of time
Other analyses	bone analysis, blood analysis		Blood (U rapidly went from blood to urine)
Comments	Summary of - Struxness et al., 1955 - Bernard et al., 1956 - Bernard et al., 1957 All 3 experiment were carried out at the Oak Ridge National Laboratory. A similar summary can also be found in Hursh and Spoor, 1973.		Found kidney and skelton were principal sites of deposition. Reviewed many other studies. Concluded that kidney is critical organ due to chemical toxicity of U (10 time more than radiological toxicity). Did MPC_a, MPC_w calculations.

Table 4.b

COMPARISON OF CATALOGUING BY THREE RESEARCHERS

Author(s)	Scott, L.M., and West, C.M.		
Title	An Evaluation of U_3O_8 Exposure with an Estimate of Systematic Body Burden		
Publication	Health Physics, 196758, Vol. 13, pp. 21-26		
Authors' Affiliation	Union Carbide Corporation, Nuclear Division, Y-12 Plant, Oak Ridge		
Subject of Study	1 worker	1 male human	monitoring of employee exposed to U_3O_8 dust
Type of Exposure	Accidental and Occupational	Occupational	Exposure to burning U metal
Administration	Inhalation	Inhalation	Inhaled
Chemical Form	U_3O_8 (enriched)	U_3O_8 (90% U-235) Fumes from drilling uranium metal	U_3O_8 (90% U-235)
Dosage/Exposure	N/A (air sampling done during mock-up of the exposure)	approximately 200,000 pCi U_3O_8 (90% U-235)	approximately 2×10^5 pCi of U_3O_8
Duration of Exposure	< 10 days	$\leq$ 10 days	unknown but < 10 days
Follow-up Period	1200 days	1200 days	1200 days (to background levels)
In Vivo Measurement	Yes	4 to 1200 days	Yes - 8 x 4 detectors
Postmortem Tissue Analysis	No	No	No
Urine analysis	Yes	Yes - from 4 to 1200 days after exposure	U in urine as function of time (0 to 1200 days)
Fecal analysis	Yes	Yes - from 8 to 11 days after exposure	5 samples 8 to 11 days after exposure - discontinued because of low U values
Other analyses	No		Air samples taken at mock-up accident determined the material to be U_3O_8
Comments	Followup initiated after the accident		Fitted excretion data to estimate biological half-lives. Range from t1/2 = 7 days to 7200 days for long component.

Table 5

AUTHORS LISTED BY COUNTRY AND CENTRE OF RESEARCH

AUSTRALIA

Atomic Energy Commission, Lucus Heights Res. Lab. - Bentley, Wyatt, Wilson, Dixon
Australia National Univ., Canberra - Bentley, Stockwell, Britt, Kerr

CANADA

Atomic Energy of Canada Limited - Johnson, Dunford
Atomic Energy Control Board - Jardine, Napier, Chatterjee, Healey, Horvath, Stocker
Guelph, Univ. of - Robinson, Wasnidge, Eloto, Kupsh
Health and Welfare Canada, Bureau of Chemical Hazards - Gilman
Health and Welfare Canada, Radiation Protection Bureau - Measures, Pomroy, Taniguchi, Quastel, Overton, Abbatt, Limson - Zamora

GERMANY

Karlsruhe - Schieferdecker, Dilger, Doerel, Sontag

SWEDEN

Sabbatsberg Sjukhus, Stockholm - Wallinder, Fries, Billaudelle, Hammarstrom

UNITED KINGDOM

Atomic Energy Estab., Winfrith -Bains, Rowbury
Atomic Energy Res. Estab., Harwell - Jackson, Dolphin
British Nuclear Fuels - Risley, Donoghue, Sedgwick, Cooke, Shaw
Medical Research Council, Harwell - Patrick, Gore, Batchelor, Jenner, Papworth
National Radiological Protection Board, Harwell - Adams, Spoor, Dyson, Harrison, Stather, Stradling, Ellender, Sumner, Moody, Towndrow, Hodgson, Smith, Cooper, Ham, Halcon
Radiation Protection Service - Hamilton

UNITED STATES

Argonne National Laboratory - Rowland, Farnham, Kisieleski, Faraghan, Norris, Arnold, Keane, Polednak, Rundo
Battelle Northwest Laboratory - Heid, Stuart, Filipy, Palmer, Ragan, Hackett, Fisher, Cross
Hanford Environmental Health Foundation - Fuqua
Lawrence Berkeley Lab. -Durbin
Los Alamos National Lab. - Rodgers, Buhl, Lawrence
Lovelace Biomedical and Environmental Res. Inst. - Damon, Eidson, Hahn, Griffith, Guilmette, Mewhinney, Pickrel
National Lead Co. - Wing, Heatherton, Boback, Quigley
North Carolina, Univ. of - Crawford-Brown, Wilson
Nuclear Regulatory Commission - Brodksy, Alexander

Table 5, continued.

UNITED STATES

Oak Ridge National Lab. - West, Scott, Schultz, Fish, Fernard, Hunt
Pacific Northwest Lab. - Ballou, Gies, Case, Haggard, Buschbom, Ryan
Rochester, Univ. of - Hodge, Hursh, Leach, Yuile, Morrow, Gibb, Beiter, Neuman, Downs, Wilson, Sylvester, Maynard, Scott, Johnson
United States Atomic Energy Commission - Eisenbud
United States Atomic Energy Commission, Health and Safety Lab. - Lippman, Welford, Baird, Ong, Harris
Uranium Registry - Kathren
Utah, Univ. of - Wrenn, Stevens, Bruenger, Atherton, Smith, Taylor

YUGOSLAVIA

Institut za Medicinu Rada, Belgrade - Karajovic, Kilibarda, Panov, Medjedovic, Raicevic, Delic

3.0 CATALOGUE OF HUMAN DATA

HUMAN

Author	Ad Hoc Interagency Public Health Assessment Task Force
Title	Assessment of the Public Health Impact from the Accidental Release of UF_6 at the Sequoyah Fuels Corporation Facility at Gore, Oklahoma
Publication	NUREG-1189
Authors' Affiliation	U.S. Nuclear Regulatory Commission
Subject of Study	33 humans
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	UF_6
Dosage/Exposure	Unknown
Duration of Exposure	Short term
Follow-up Period	11 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	
Comments	

HUMAN

Author	Avadhanula, M.R., Chatterjee, R.M., Healey, G.J., Horvath, F.J., Measures, M.P., Stocker, H., Pomroy, C.T., Johnson, J.R. and Dunford, D.W.
Title	Canadian Uranium Fuel Fabrication Study: I. Intake, Retention and Excretion Monitoring Results; II Comparison of Results to Metabolic Models.
Publication	In Proc. Of Int. Sym. on the Assessment of Radioactivity Contamination in Man, Paris, France, 19-23 November 1984, IAEA-SM-276
Authors' Affiliation	Atomic Energy Control Board, Radiation Protection Bureau and Chalk River Nuclear Laboratories
Subject of Study	25 Active workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UO_2
Dosage/Exposure	Pulmonary deposition estimates of 38.7 and 15.1 ug/work day in each of two groups
Duration of Exposure	2.5 - 21 years
Follow-up Period	2 years
In Vivo Measurement	Thorax
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Workers of 2 uranium fuel fabrication facilities were studied.

HUMAN

Author	Bains, M.E.D. and Rowbury, P.W.J.
Title	The Biological Excretion Pattern from a Person Involved in the Inhalation of a Mixture of Enriched Uranium Oxide and Lead Metal Powders
Publication	Health Physics, 1969, Vol. 16, pp. 449-453
Authors' Affiliation	Atomic Energy Establishment, England
Subject of Study	One Operator
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	Uranium Oxide (enriched)
Dosage/Exposure	daily intakes ranged from 0.3 to 140 ug (personal air sampling)
Duration of Exposure	50 days
Follow-up Period	32 months
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Exposure occured during a pellet processing operation.

HUMANS

Author	Bernard, S.R. and Struxness, E.G.
Title	A Study of the Distribution and Excretion of Uranium in Man - An Interim Report.
Publication	Report No. ORNL-2304, 1957
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	8 Terminal Patients
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	Hexavalent or Tetravalent Uranium
Dosage/Exposure	4-50 mg U
Duration of Exposure	Single Injection
Follow-up Period	300 days
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Blood, biopsy samples
Comments	Information on this summary was obtained from the abstract only.

HUMAN

Author(s)	Bernard, S.R.
Title	Maximum Permissible Amounts of Natural Uranium in the Body, Air and Drinking Water Based on Human Experimental Data
Publication	Health Physics, 1958, Vol. 1, pp. 288-305
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	8 terminal patients
Type of Exposure	controlled
Administration	intravenous injection
Chemical Form	6 : hexavalent uranium 2 : tetravalent uranium
Dosage/Exposure	4-50 mg of uranium
Duration of Exposure	one injection
Follow-up Period	to death (25 - 556 days)
In Vivo Measurement	no
Postmortem Tissue Analysis	yes
Urine analysis	yes
Fecal analysis	yes
Other analyses	bone analysis, blood analysis
Comments	Summary of - Struxness et al., 1955 - Bernard et al., 1956 - Bernard et al., 1957 All 3 experiments were carried out at the Oak Ridge National Laboratory. A similar summary can also be found in Hursh and Spoor, 1973.

HUMAN

Author	Campbell, E.E., McInroy, J.F. and Schulte, HF.
Title	Uranium in the Tissue of Occupationally Exposed Workers
Publication	Report No. CONF-750445-7, 1975
Authors' Affiliation	Los Alamos Scientific Laboratory
Subject of Study	Deceased Uranium Workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	Yes (during period of working)
Fecal analysis	No
Other analyses	No
Comments	Information was obtained from the abstract only.

HUMAN

Author	Chalabreysse, J.
Title	Etudes et resulats d'examens effectues a la suite d'une inhalation de composes dits solubles d'uranium naturel
Publication	Radioprotection, 1970, Vol. 5, pp. 1-17, and pp. 305-310
Authors' Affiliation	N/A
Subject of Study	3 cases of Human Exposure
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	Uranium hexafluoride
Dosage/Exposure	0.94 - 20 mg (estimation)
Duration of Exposure	N/A (minutes)
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author	Cofield, R.E.
Title	In Vivo Gamma Counting as a Measurement of Uranium in the Human Lung
Publication	Health Physics, 1960, Vol. 2, pp. 269-287
Authors' Affiliation	Oak Ridge Y-12 Plant
Subject of Study	4 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	Uranium Dioxide
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	Up to 18 months
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Workers whose work categories and/or work areas suggest that they might be exposed to inhalation of uranium were selected for the analysis.

HUMAN

Author(s)	Donoghue, J.K., Dyson, E.D., Hislop, J.S., Leach A.M. and Spoor, N.L.
Title	Human Exposure to Natural Uranium - A Case History and Analytical Results from Some Postmortem Tissues
Publication	Brit. J. Industr. Med., 1972, Vol. 29, pp. 81-89
Authors' Affiliation	United Kingdom Atomic Energy Authority
Subject of Study	1 worker
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	85% U_3O_8 and 15% UO_2
Dosage/Exposure	300 ug/m^3 average concentration in air
Duration of Exposure	10 years
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes (6 tissues)
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Sudden collapse death (from natural causes) of an employee who had been exposed to airborne uranium for 10 years in a natural uranium workshop. Urine analysis data from routine end-of-shift samples during the 10 years of employment were presented.

HUMAN

Author(s)	Eisenbud, E.E., and Quigley, J.A.
Title	Industrial Hygiene of Uranium Processing
Publication	A.M.A. Arch. Indust. Health, 1956, Vol. 14, pp. 12-22
Authors' Affiliation	U.S. Atomic Energy Commission and National Lead Company of Ohio
Subject of Study	2 deceased workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_4 and UO_2 dust
Dosage/Exposure	5,000 and 17,000 γ/m^3 (see comments)
Duration of Exposure	12 and 24 months
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	15 and 10 months between last exposure and death (non-occupational). 50 γ/m^3 is equivalent to approximately 5.1×10^{-11} µCi/mL.

HUMAN

Author(s)	Eisenbud, E.E., and Quigley, J.A.
Title	Industrial Hygiene of Uranium Processing
Publication	A.M.A. Arch. Indust. Health, 1956, Vol. 14, pp. 12-22
Authors' Affiliation	U.S. Atomic Energy Commission and National Lead Company of Ohio
Subject of Study	5 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_4 and UO_2 dust
Dosage/Exposure	N/A
Duration of Exposure	2.5 - 6.7 years
Follow-up Period	No
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	U content in bone
Comments	Bone samples were made available through 4 deaths and one surgery.

HUMAN

Author(s)	Eisenbud, E.E., and Quigley, J.A.
Title	Industrial Hygiene of Uranium Processing
Publication	A.M.A. Arch. Indust. Health, 1956, Vol. 14, pp. 12-22
Author's Affiliation	U.S. Atomic Energy Commission and National Lead Company of Ohio
Subject of Study	142 active workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_4 and UO_2 dust
Dosage/Exposure	(0.23 - 49) 5.1×10^{-11} uc Ml (μCi/mL SENES Interpretation)
Duration of Exposure	N/A
Follow-up Period	Routine follow-up
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Lows, highs, and averages of routine urine analyses were presented. Duration of follow-up was not specified.

HUMAN

Author(s)	Eisenbud, E.E., and Quigley, J.A.
Title	Industrial Hygiene of Uranium Processing
Publication	A.M.A. Arch. Indust. Health, 1956, Vol. 14, pp. 12-22
Authors' Affiliation	U.S. Atomic Energy Commission and Lead Company of Ohio
Subject of Study	1 worker
Type of Exposure	Accidental and Occupational
Administration	Inhalation
Chemical Form	Uranium oxide fume
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	70 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Follow-up of the subject began after the accident (explosion).

HUMAN

Author(s)	Eisenbud, E.E., and Quigley, J.A.
Title	Industrial Hygiene of Uranium Processing
Publication	A.M.A. Arch. Indust. Health, 1956, Vol. 14, pp. 12-22
Authors' Affiliation	U.S. Atomic Energy Commission and National Lead Company of Ohio
Subject of Study	1 ex-worker
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_4 and UO_2 dust
Dosage/Exposure	N/A
Duration of Exposure	Several years
Follow-up Period	900 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Follow-up began after resignation.

HUMAN

Author	Fisenne, I.M., Keller, H.W. and Perry, P.M.,
Title	Notes on "Uranium and 226-Ra in Human Bone from Russia"
Publication	Health Physics, 1984, Vol. 46, pp. 438-439
Authors' Affiliation	Environmental Measurements Laboratory U.S. Department of Energy
Subject of Study	Russian Residents
Type of Exposure	Environmental
Administration	Inhalation and Ingestion
Chemical Form	Natural Uranium
Dosage/Exposure	N/A
Duration of Exposure	No
Follow-up Period	No
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	Bone sample uranium analysis
Comments	5 bone types were obtained from 6 Moscow residents for analysis.

HUMAN

Author	Fisenne, I.M., Perry, P.M., Chu, N.Y. and Hawley, N.H.
Title	Measured 234, 238U and Fallout 239, 240 Pu in Human Bone Ash from Nepal and Australia: Skeletal Alpha Dose
Publication	Health Physics, 1983, Vol. 44, Suppl. 1, pp. 457-467
Authors' Affiliation	Environmental Measurements Laboratory
Subject of Study	Human Bone Samples
Type of Exposure	Environmental
Administration	Inhalation and Ingestion
Chemical Form	234U, 238U
Dosage/Exposure	N/A but air sampling data of 1954-1978 was incorporated
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	Bone analysis
Comments	Bone samples were obtained from Nepal and Australia, and were analyzed for isotopic uranium and fallout plutonium. The Nepalese samples were obtained for a 3-year period (1976-78) while the Australian Samples were representative of a single year (1977).

HUMAN

Author	Fish, B.R.
Title	Inhalation of Uranium Aerosols by Mouse, Rat, Dog and Man
Publication	Inhaled Particles and Vapour (ed. C.N. Davies), 1961, pp. 151-166, Pergamon Press, Oxford
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	One employee
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	U_3O_8 (enriched)
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	Approximately 375 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The subject was exposed while he was changing the dust filters on the ventilation system surrounding a foundry handling enriched uranium.

HUMAN

Author	Fish, B.R.
Title	Inhalation of Uranium Aerosols by Mouse, Rat, Dog, and Man
Publication	Inhaled Particles and Vapours, (ed. C.N. Davies), 1961, pp. 151-166, Pergamon Press, Oxford
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	One employee
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	Uranium octoxide (enriched)
Dosage/Exposure	4 αd/m M^3 (measurement taken > 12 ft distant from the worker) (alpha disintegrations per minute per cubic metre air)
Duration of Exposure	11 days
Follow-up Period	Approximately 525 days
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The machinist was exposed during an operation which consisted in deburring holes that had been drilled in pieces of uranium metal. Exposure was detected through the routine uranium uranalysis program. The worker was transferred to a non-uranium shop after detection.

HUMAN

Author(s)	Fisher, D.R., Jackson, P.O., Brodaczynski, G.G. and Scherpelz, R.I.
Title	Levels of 234-U, 238-U and 230-Th in Excreta of Uranium Mill Crushermen
Publication	Health Physics, 1983, Vol. 45, pp. 617-629
Authors' Affiliation	Battelle Pacific Northwest Laboratory
Subject of Study	4 retired workers (uranium mill)
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	^{234}U or ^{238}U
Dosage/Exposure	N/A
Duration of Exposure	5 - 20 years
Follow-up Period	3 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	3 controls receiving environmental exposures were presented in the same study. The purpose of the study was to determine whether 230-Th was preferentially retained in the body of crushmen over 234-U or 238-U.

HUMAN

Author(s)	Fisher, D.R., Jackson, P.O., Brodaczynski, G.G. and Scherpelz, R.I.
Title	Levels of 234-U, 238-U and 230-Th in Excreta of Uranium Mill Crushermen
Publication	Health Physics, 1983, Vol. 45, pp. 617-629
Authors' Affiliation	Battelle Pacific Northwest Laboratory
Subject of Study	14 active crushermen
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	^{234}U or ^{238}U
Dosage/Exposure	N/A
Duration of Exposure	5 - 20 years
Follow-up Period	3 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	3 controls who received environmental exposures were presented in the same study. The purpose of the study was to determine whether 230-Th was preferentially retained in the body over 234-U or 238-U.

HUMAN

Author(s)	Hamilton, E.I.
Title	The Concentration of Uranium in Man and His Diet
Publication	Health Physics, 1972, Vol. 22, pp. 149-153
Authors' Affiliation	Radiation Protection Service, Sutton, England
Subject of Study	Normal Human
Type of Exposure	Environmental
Administration	Inhalation and Oral
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Tissue samples were obtained from hospitalized and accident cases.

HUMAN

Author(s)	Harris, W.B.
Title	Experimental Clearance of Uranium Dust from the Human Body
Publication	Inhaled Particles and Vapours, (ed. C.N. Davies), 1961, pp. 209-220, Pergamon Press, Oxford
Authors' Affiliation	U.S. Health and Safety Laboratory
Subject of Study	One man
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	12 periods of UO_2 5 periods of UF_4
Dosage/Exposure	Approximately 30 mg of uranium in total
Duration of Exposure	17 short periods of exposure over a total elapsed 24 days
Follow-up Period	200 hours
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	

HUMAN

Author(s)	Heatherton, R.C., Boback, M.W. and Quigley, J.A.
Title	A Continued Program of Analysis for Uranium
Publication	Proceedings of the Ninth Annual Conference on Bio-Assay and Analytical Chemistry, 10 and 11 October, 1963, San Diego, California
Authors's Affiliation	National Lead Company of Ohio
Subject of Study	10 workers and 6 controls
Type of Exposure	Occupational & Environmental
Administration	Inhalation
Chemical Form	N/A
Dosage/Exposure	Minimal to >100 ug/m^3 air
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Tissue sources included 6 autopsies, 3 biopsies, 1 surgery, and 1 accident

HUMAN

Author(s)	Heid, K.R. and Fuqua, P.A.
Title	Review of Uranium Inhalation Case
Publication	Health Physics, 1974, Vol. 26, pp. 339-403
Authors' Affiliation	Battelle Northwest Laboratory, Washington and Hanford Environmental Health Foundation
Subject of Study	1 worker
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	14 years
Follow-up Period	Routine weekly checkup over 4 year period
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Subject singled out due to sustained chest burden over a 7-month period.

HUMAN

Author(s)	Howland, J.W.
Title	Studies on Human Exposures to Uranium Compounds
Publication	Pharmacology and Toxicology of Uranium Compounds (ed. C. Voegtlin and H.C. Hodge), 1949, pp. 993-1017, McGraw-Hill, New York
Authors' Affiliation	N/A
Subject of Study	18 persons
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	UF_6 and UO_2F_2
Dosage/Exposure	N/A
Duration of Exposure	Seconds - 5 minutes (17 second average)
Follow-up Period	Up to 16 days
In Vivo Measurement	No
Postmortem Tissue Analysis	On 2 persons
Urine analysis	Yes
Fecal analysis	No
Other analyses	Blood analysis (blood counts, blood chlorides, serum cholesterol, total proteins etc.)
Comments	Summary of control activities of the medical section of the Manhattan District. An accident involving rupture of hexafluoride gas tank with the simultaneous rupture of high-pressure steam lines was the cause of inhalation.

HUMAN

Author(s)	Hursh, J.B, Neuman, W.R., Toribara, T., Wilson, H and Waterhouse, C.
Title	Notes on "Oral Ingestion of Uranium by Man"
Publication	Health Physics, 1969, Vol 17, pp. 619-621
Authors' Affiliations	University of Rochester
Subject of study	4 volunteers
Type of Exposure	Controlled
Administration	Oral Ingestion
Chemical Form	Uranyl nitrate hexahydrate
Dosage/Exposure	10.8 mg of uranium (intake)
Duration of Exposure	1 dose
Follow-up Period	8 - 15 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Also, one subject was tested for uranium content in urine and fecal samples 5 months post-exposure.

HUMAN

Author	Igarashi, Y., Yamakawa, A., Seki, R. and Ikeda, N.
Title	Determination of Uranium in Japanese Human Tissues by the Fission Track Method
Publication	Health Physics, 1985, Vol. 49, pp. 707-712
Authors' Affiliation	University of Tsukuba, Ibaraki, Japan
Subject of Study	Human Tissues
Type of Exposure	Environmental
Administration	Inhalation and Ingestion
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	No
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Uranium content in tissues obtained from Japanese in the Tokyo area was determined by fission track method. The content of this summary was obtained from the abstract only.

HUMAN

Author	Kathren, R.L. and Moore, R.H.
Title	Acute Accidental Inhalation of U: A 38-Year Follow-Up
Publication	Health Physics, 1986, Vol. 51, pp.609-619
Authors' Affiliation	United States Uranium Registry
Subject of Study	2 Workers
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	Uranium Hexafluoride
Dosage/Exposure	NA
Duration of Exposure	Seconds - 5 minutes
Follow-up Period	38 years
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Continuing followup of 2 survivors of an accident reported in Howland, 1949.

HUMAN

Author(s)	Lippmann, M.
Title	Environmental Exposure to Uranium Compounds
Publication	A.M.A. Arch. Indust. Health, 1959, vol. 20(3), pp. 211-226
Authors' Affiliation	Health and Safety Laboratory, U.S. Atomic Energy Commission
Subject	> 14 workers from Plant 1
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UO_2 and UF_4
Dosage/Exposure	1300 to 9700 ug/m^3 air
Duration of Exposure	Maximum of 9 years
Follow-up Period	2 years
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Subjects of study were employees of a refinery where UO_2 was hydrofluorinated to UF_4. Monthly average air concentrations depend largely on job types and usage of respirators.

HUMAN

Author(s)	Lippmann, M.
Title	Environmental Exposure to Uranium Compounds
Publication	A.M.A. Arch. Indust. Health, 1959, vol. 20(3), pp. 211-226
Authors' Affiliation	Health and Safety Laboratory, U.S. Atomic Energy Commission
Subject of Study	> 74 workers from Plant 2
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_6 and UO_2F_2
Dosage/Exposure	Up to 5500 ug/m^3 of air (monthly average)
Duration of Exposure	Maximum of 9 years
Follow-up Period	2 years
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Subjects of study were employees of a refinery where UF_4 was fluorinated to UF_6. Monthly average air concentrations depend largely on job types. Loaders, operators, redistillation operators, and shipping and receiving personnel were all included in study.

HUMAN

Author	Lippmann, M., Ong, L.D.Y. and Harris, W.B.
Title	The Significance of Urine Uranium Excretion Data
Publication	Am. Ind. Hyg. Assoc. J., 1964, Vol. 25, pp. 43-54
Authors' Affiliation	Health and Safety Laboratory, U.S. Atomic Energy Commission, N.Y.
Subject of Study	8 people
Type of Exposure	Accidental
Administration	Inhalation, some (4) also ingestion
Chemical Form	UF_4, UO_3, U_3O_8, or mixed
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	32-4100 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	8 Chronic exposure cases were studied.

HUMAN

Author	Luessenhop, A.J., Gallimore, J.C., Sweet, W.H., Struxness, E.G. and Robinson, J.
Title	The Toxicity in Man of Hexavalent Uranium Following Intravenous Administration
Publication	Am. J. Roent., 1958, Vol. 79, pp. 83-100
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	5 Terminal Patients
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	Uranyl Nitrate
Dosage/Exposure	0.097, 0.12, 0.07, 0.17 and 0.28 mg U/kg
Duration of Exposure	Single injection
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only

HUMAN

Author	Marao, S.R.
Title	Natural Uranium: A Study on Excretion and Retention in Bone Tissue for Inhabitants of Rio de Janeiro, Brazil
Publication	Report No. INIS-MF-7479
Authors' Affiliation	Universidade do Estado do Rio de Janeiro
Subject of Study	Rio de Janeiro City residents
Type of Exposure	Environmental
Administration	Inhalation
Chemical Form	Natural uranium
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Paper is in Portuguese. Information was obtained from the English abstract.

HUMAN

Author(s)	Pomroy, C., Measures, M., Jardine, J.M. and Napier, W.A.
Title	Bioassay Studies of Canadian Uranium Mill Workers
Publication	Radiation Hazards in Mining (ed. Gomez), 1981, pp. 393-399
Authors' Affiliation	Radiation Protection Bureau, Ottawa, Atomic Energy Control Board, Ottawa
Subject of Study	79 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	Yellowcake aerosols
Dosage/Exposure	0.009 - 0.117 mg/m^3 of air (data of year 1980)
Duration of Exposure	1 - 25 years
Follow-up Period	N/A
In Vivo Measurement	Thorax
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Subjects were workers of 3 uranium mills including 19 staff, 18 maintenance, 36 operations, and 6 laboratory employees. One examination only. Subjects were brought to the laboratories in groups of 4 to 6 over a period of several months.

HUMAN

Author(s)	Pomroy, C., and Noel, L.
Title	Notes on "Retention of Uranium Thorax Burdens in Fuel Fabricators"
Publication	Health Physics, 1981, Vol. 41, pp. 393-399
Authors' Affiliation	Radiation Protection Bureau, Health and Welfare
Subject of Study	44 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	Class W and Y dusts
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	Nearly 2 years
In Vivo Measurement	Thorax
Postmortem Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Subjects were uranium fuel fabrication workers for the CANDU reactor. Many received further exposures during study period.

HUMAN

Author(s)	Quastel, M.R., Taniguchi, H., Overton, T.R. and Abbatt, J.D.
Title	Excretion and Retention by Humans of Chronically Inhaled Uranium Dioxide
Publication	Health Physics, 1970, Vol. 18, pp. 233-244
Authors' Affiliation	Department of National Health and Welfare, Ottawa
Subject of Study	15 workers (uranium mill)
Type of Exposure	Occupation
Administration	Inhalation
Chemical Form	Uranium oxides
Dosage/Exposure	N/A
Duration of Exposure	1 - 20 years
Follow-up Period	3 - 4 days
In Vivo Measurement	Whole body
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Entire study spanned over 2 month period

HUMAN

Author(s)	Ronen, M.
Title	A Case of Insoluble Natural Uranium Exposure: A two-year Follow-up Study
Publication	IAEA Paper SM-119/17, Vienna, 1969.
Authors' Affiliation	-
Subject of Study	1 employee
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	Uranium oxides (probably) other Uranium compounds (natural)
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	2 years
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Close watch initiated after a high U urine sample. The content of this summary was extracted from Hursh and Spoor (1973) only

HUMAN

Author(s)	Rundo, J.
Title	A Case of Accidental Inhalation of Irradiated Uranium
Publication	Brit. J. Radiol., 1965, vol. 38, pp. 39-50
Authors' Affiliation	Atomic Energy Research Establishment, Harwell, Berks
Subject of Study	1 worker
Type of Exposure	Accidental
Administration	Inhalation
Chemical Form	Irradiated uranium
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	858 days
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Subject was isolated for observation due to a high measurement of radioactivity made during routine examination. The chemical form was identified as uranium dioxide when used by the TGLD in modelling.

HUMAN

Author	Saxby, W.N. and Rundo, J.
Title	A Case of Inhalation of Enriched Uranium Dust
Publication	In Assessment of Radioactivity in Man, Vol. 2, pp. 535-547, Vienna: IAEA, 1964.
Authors' Affiliation	Aldermaston Harwell
Subject of Study	2 persons
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	Uranium oxide or silicate (enriched) U_3O_8
Dosage/Exposure	N/A
Duration of Exposure	18 months
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author(s)	Schieferdecker, H., Dilger, H., Doerfel, H., Rudolph, W. and Anton, R.
Title	Inhalation of U Aerosols from UO_2 Fuel Element Fabrication
Publication	Health Physics, 1985, vol. 48, pp. 28-48
Authors' Affiliation	Kernforschungszentrum Karlsruhe and Nukem GmbH, Federal Republic of Germany
Subject of Study	12 employees
Type of Exposure	Occupational
Administration	Inhalational
Chemical Form	UO_2, U_3O_8, UO_3, UF_6, UF_4, U solution
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	5 + years Part 1: 21 days; Part 2: 3 days
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Part 1: Measurements taken before, during and after a 2-3 week holiday. Part 2: Measurements taken after half a year of returning to work from holiday.

HUMAN

Author	Schultz, N.B.
Title	Inhalation Cases of Enriched Soluble Uranium Oxides
Publication	Report K-C-822. Proceedings to the First International Congress of the International Radiation Protection Association, September 5-1-, 1966
Authors' Affiliation	Oak Ridge
Subject of Study	4 Chemical Operators
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	U_3O_8 (enriched)
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author(s)	Scott, L.M.
Title	Excretion of Uranium from Mixed Exposures Under Industrial Conditions
Publication	Health Physics, 1964, Vol. 10, pp.479-481
Authors' Affiliation	Union Carbide Corporation, Nuclear Division Y-12 Plant, Oak Ridge
Subject of Study	157 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_6 and other subsequent uranium products
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	200 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The 157 workers were removed from uranium processing areas. At the Y-12 plant, uranium is received as UF_6, converted to green salt, reduced to metal and subsequently fabricated into nuclear weapon parts.

HUMAN

Author(s)	Scott, L.M., and West, C.M.
Title	An Evaluation of U_3O_8 Exposure with an Estimate of Systematic Body Burden
Publication	Health Physics, 1967, vol. 13, pp.21-26
Authors' Affiliation	Union Carbide Corporation, Nuclear Division, Y-12 Plant, Oak Ridge
Subject of Study	1 worker
Type of Exposure	Accidental and Occupational
Administration	Inhalation
Chemical Form	U_3O_8 (enriched)
Dosage/Exposure	N/A (air sampling done during a mock-up of the exposure)
Duration of Exposure	< 10 days
Follow-up Period	1200 days
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Followup initiated after the accident.

HUMAN

Author	Scott, L.M. and West, C.M.
Title	Detection and Evaluation of Uranium Exposure
Publication	Assessment of Radioactivity in Man, Vol. II, pp.523-533, Vienna, IAEA, 1964.
Authors' Affiliation	Union Carbide Corporation, Nuclear Division, Y-12 Plant, Oak Ridge
Subject of Study	4 Workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UF_6, UF_4, $UO_2(NO_3)_2$, U_3O_8, UO_2
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Subjects were found to have excessive retention during routine in vivo measurements. The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author	Stradling, G.N., Smith, H., Cooper, J.R., Ham, S.E., Cooke, N., Sedgwick, D. and Shaw, R.S.T.
Title	Factors Affectng the Abundance of Uranium Isotopes in Body Tissues and Excreta Following the Deposition of Enriched Uranium Dioxide in the Lungs - The Radiological Implications
Publication	Health Physics, 1984, V01. 46, pp. 434-438.
Authors' Affiliation	National Radiological Protection Board and British Nuclear Fuels Limited
Subject of Study	2 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	UO_2 (enriched)
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Sacrifice and Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	

HUMAN

Author	Terepka, A.R., Toribara, T.Y. and Heuman, W.T.
Title	Skeletal Retention of Uranium in Man
Publication	Proceedings to the 46th Meeting of the Endocrine Society, San Francisco, 18 June, 1964.
Authors' Affiliation	
Subject of Study	10 patients
Type of Exposure	Controlled
Administration	Intravenous injection
Chemical Form	Hexavalent natural uranium
Dosage/Exposure	30 ug/kg
Duration of Exposure	One injection
Follow-up Period	6 days
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	Blood
Comments	3 patients without bone disease and 7 patients with a variety of bone disorder. The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author	Welford, G.A. and Baird, R.
Title	Uranium Levels in Human Diet and Biological Materials
Publication	Health Physics, 1967, Vol. 13, pp. 1321-1324
Authors' Affiliation	Health and Safety Laboratory USAEC, N.Y.
Subject of Study	Residents of 3 U.S. Cities
Type of Exposure	Environmental
Administration	Inhalation and Ingestion
Chemical Form	N/A
Dosage/Exposure	1.3 - 1.4 ug of uranium per day (intake)
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	Yes (lung tissue)
Urine analysis	Yes
Fecal analysis	No
Other analyses	Water
Comments	The uranium intake measurements were made on average diets of New York City, Chicago, and San Francisco residents.

HUMAN

Author(s)	West, C.M. and Scott, L.M.
Title	A Comparison of Uranium Cases Showing Long Chest Burden Retentions
Publication	Health Physics, 1966, vol. 12, pp. 1545-1555
Authors' Affiliation	Union Carbide Corporation - Nuclear Division Y-12 Plant, Oak Ridge
Subject	5 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	14-34 months
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Subjects were temporarily removed from uranium handling areas. Subjects were identified to exhibit abnormal excretion pattern from routine in vivo gamma spectrum measurements.

HUMAN

Author(s)	West, C.M. and Scott, L.M.
Title	Uranium Cases Showing Long Chest Burden Retention - An Updating
Publication	Health Physics, 1969, vol. 17, pp. 781-791
Authors' Affiliation	Union Carbide Corporation, Nuclear Division, Oak Ridge Y-12 Plant
Subject of Study	4 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	Further 3.5 years
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Subjects of previous study in 1966. (West and Scott)

HUMAN

Author(s)	West, C.M., Scott, L.M. and Schultz, N.B.
Title	Sixteen Years of Uranium Personnel Monitoring Experience - In Retrospect
Publication	Health Physics, 1979, vol. 36, pp. 665-669
Authors' Affiliation	Union Carbide Corporation, Nuclear Division, Oak Ridge Y-12 Plant
Subject of Study	49 workers
Type of Exposure	Occupational
Administration	Inhalation
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	Minimum of 6 months
In Vivo Measurement	Yes
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Subjects were temporarily removed from work due to elevated levels of uranium detected during routine monitoring program.

HUMAN

Author	Wilson, R.H.
Title	The Hanford Uranium Bio-Assay Program
Publication	U.S.AEC Report HASL-58
Authors' Affiliation	N/A
Subject of Study	1 Worker
Type of Exposure	Accidental
Administration	Ingestion and Absorption
Chemical Form	Uranium nitrate solution
Dosage/Exposure	2.0 mg uptake (estimation)
Duration of Exposure	1 minute
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Worker fell into vat. The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author	Wilson, R.H.
Title	The Hanford Uranium Bio-Assay Program
Publication	U.S.AEC Report HASL-58
Authors' Affiliation	N/A
Subject of Study	One Worker
Type of Exposure	Accidental (respiratory protection failure)
Administration	Inhalation and Ingestion
Chemical Form	Uranium trioxide
Dosage/Exposure	500 mg (estimated uptake)
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The content of this summary was extracted from Hursh and Spoor, 1973 only.

HUMAN

Author	Wilson, R.H.
Title	The Hanford Uranium Bio-Assay Program
Publication	U.S.AEC Report HASL-58
Authors' Affiliation	N/A
Subject of Study	One worker
Type of Exposure	Accidental (fire)
Administration	Inhalation
Chemical Form	U_3O_8 fume
Dosage/Exposure	0.4 mg (estimated intake)
Duration of Exposure	4 minutes
Follow-up Period	20 days
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	

HUMAN

Author	Wing, J.F.
Title	Background Urinary Uranium Levels in Humans
Publication	Health Physics, 1965, Vol. 11, pp.731-735
Authors' Affiliation	National Lead Company of Ohio
Subject of Study	Pre-employees
Type of Exposure	Environmental
Administration	Inhalation and Ingestion
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	One-time sampling
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Urine specimens were taken at the National Lead Company of Ohio during pre-employment examinations over the 5 year period of 1958-1962. 1081 results were assembled though the number of subjects involved was not specified.

HUMAN

Author	Wing, J.F., Heatherton, R.C. and Quigley, J.A.
Title	Accidental Acute Inhalation Exposure of Humans to Soluble Uranium
Publication	Report NLCO-951, Prepared for the Tenth Annual Meeting of the Health Physics Society,Los Angeles, California, 1965.
Authors' Affiliation	
Subject of Study	7 cases of human exposure
Type of Exposure	Accidental leakage
Administration	Inhalation
Chemical Form	Uranium hexafluoride
Dosage/Exposure	N/A
Duration of Exposure	0.5-7 minutes
Follow-up Period	N/A
In Vivo Measurement	No
Postmortem Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The content of this summary was extracted for Hursh and Spoor, 1973 only.

4.0 CATALOGUE OF ANIMAL DATA

ANIMALS

Author	Ballou, J.E., Gies, R.A., Case, A.C., Haggard, D.L., Buschbom, R.L. and Ryan, J.L.
Title	Deposition and Early Dispostion of Inhaled $^{233}UO_2$ $(NO_3)_2$ and $^{232}UO_2$ $(NO_3)_2$ in the Rat
Publication	Health Physics, 1986, Vol. 51, pp. 755-771
Authors' Affiliation	Pacific Northwest Laboratory, Richland
Subject of Study	300 rats
Type of Exposure	Controlled
Administration	Inhalation (nose-only)
Chemical Form	UO_2 $(NO_3)_2$
Dosage/Exposure	N/A
Duration of Exposure	30 minutes
Follow-up Period	7-200 days
In Vivo Measurement	N/A
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	- 100 rats for control purpose only - 100 rats exposed to $^{233}UO_2$ $(NO_3)_2$ aerosols - 100 rats exposed to $^{232}UO_2$ $(NO_3)_2$ aerosols

ANIMALS

Author	Cooper, J.R., Stradling, G.N., Smith, H. and Ham, S.E.
Title	The Behaviour of Uranium-233 Oxide and Uranyl-232 Nitrate in Rats
Publication	J. Rad. Bio., 1982, Vol. 41, pp. 421-433.
Authors' Affiliation	British Nuclear Fuel Limited
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Incubation
Chemical Form	Uranium-233 - Oxide and Uranyl-232 nitrate
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Yes
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	Blood
Comments	The information on this summary was obtained from the abstract only

ANIMALS

Author(s)	Damon, E.G., Eidson, A.F., Hahn, F.F., Griffith, W.C. and Guilmette, R.A.
Title	Comparison of Early Lung Clearance of Yellowcake Aerosols in Rats with in vitro Dissolution and IR Analysis.
Publication	Health Physics, 1984, vol. 46, pp. 859-866
Authors' Affiliation	Lovelace Biomedical and Environmental Research Institute
Subject of Study	50 rats
Type of Exposure	Controlled
Administration	Inhalation (nose - only)
Chemical Form	A: 82% ammonia diuranate (ADU) 18% U_3O_3 D: 25% ADU and 75% U_3O_8
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	2 hours - 179 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Cage wash water
Comments	Yellowcake samples obtained from mills A & D.

ANIMALS

Author(s)	Downs, W.L., Wilson, H.B., Sylvester, G.E., Leach, L.J., and Maynard, E.A.
Title	Excretion of Uranium by Rats Following Inhalation of Uranium Dioxide
Publication	Health Physics, 1966, vol. 13, pp. 445-453
Authors' Affiliation	University of Rochester
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	Uranium oxide (natural uranium)
Dosage/Exposure	5 mg U/m^3
Duration of Exposure	17 - 140 days
Follow-up Period	1 day - 24 months
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Wash water.
Comments	27-61 rats were used for each of the 8 different exposure periods.

ANIMALS

Author	Eidson, A.F. and Damon, E.G.
Title	Biological Significant Properties of Refined Uranium Ore
Publication	N/A (Received April 1985)
Authors' Affiliation	Lovelace Inhalation Toxicology Research Institute
Subject of Study	50 Rats
Type of Exposure	Controlled
Administration	
Chemical Form	A: 82% ammonia diuranate (ADU) 18% U_3O_8 B: 25% ADU 75% U_3O_8
Dosage/Exposure	0.040-0.34 ug/L (medium)
Duration of Exposure	N/A
Follow-up Period	2 hours - 180 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Yellowcake samples were obtained from 2 uranium mills A & D. Experimental Results were compared to results of in vitro dissolution and infrared analysis studies.

ANIMALS

Author(s)	Eidson, A.F., Damon, E.G., Hahn, F.F. and Pickrell, J.A.
Title	Comparison of Uranium Retention in Dogs Exposed by Inhalation to Two Forms of Yellowcake
Publication	N/A (Received April 1985)
Authors' Affiliation	Lovelace Inhalation Toxicology Research Institute
Subject of Study	44 Beagle dogs
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	A: 100% ammonium diuranate B: > 99% U_3O_8
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	2 days - 2 years (to sacrifice)
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes (13 tissues)
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Cage wash water, blood
Comments	Yellowcake samples A and B were obtained from 2 uranium mills. They represented two extremes in yellowcake composition that occur in industry. 4 dogs for control purpose only. Single exposure only.

ANIMALS

Author	Fish, B.R.
Title	Inhalation of Uranium Aerosols by Mouse, Rat, Dog and Man
Publication	Inhaled Particles and Vapours (ed. C.N. Davies), 1961, pp. 151-166, Pergamon Press, Oxford
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	10 Adult beagles, 30 female white rats and 60 white mice
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	U_3O_8
Dosage/Exposure	N/A (air sampling done)
Duration of Exposure	11 working days
Follow-up Period	1 day - 3 months
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The aim of this study was to simulate an accident during which a machinist was exposed to U_3O_8 for 11 working days. Aerosol concentrations and exposure times thus were selected to give approximately the same lung burden in the animals after the 11th day.

ANIMALS

Author	Fish, B.R.
Title	Inhalation of Uranium Aerosols by Mouse, Rat, Dog and Man
Publication	Inhaled Particles and Vapours, (ed. C.N. Davies), 1961, pp. 151-166, Pergamon Press, Oxford
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	> 6 Mongrel dogs
Type of Exposure	Controlled
Administration	Inhalation (nose only)
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	Single inhalation
Follow-up Period	2 days - 3.5 months
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	The inhaled fume was produced by burning a small chip of enriched uranium metal.

ANIMALS

Author	Fish, B.R.
Title	Inhalation of Uranium Aerosols by Mouse, Rat,Dog and Man
Publication	Inhaled Particles and Vapours, (ed. C.N. Davies), 1961, pp. 151-166, Pergamon Press, Oxford
Authors' Affiliation	Oak Ridge National Laboratory
Subject of Study	Beagle dogs, Mice
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	U_3O_8
Dosage/Exposure	25 ug/week
Duration of Exposure	25 minutes/week (one exposure/week)
Follow-up Period	6 months; 6 weeks
In Vivo Measurement	No
Sacrifice and Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Animals were exposed 0.5 mg/m^3 in concentration of uranium aerosols and inhaled approximately 0.05 m^3 per week. Urine samples were collected from the dogs on the 5th and 6th days after each inhalation in order to simulate the industrial practice of collecting Monday morning urine sample.

ANIMALS

Author(s)	Gillman
Title	Uptake and Excretion of Uranium by Rabbits and Rats
Publication	To be published
Authors' Affiliation	Health and Welfare Canada
Subject of Study	Rabbits and rats (males and females)
Type of Exposure	Controlled experiment
Administration	Ingestion
Chemical Form	Uranyl nitrate hexahydrate
Dosage/Exposure	Natural uranium in drinking water
Duration of Exposure	91 days
Follow-up Period	91 days
In Vivo Measurement	Yes
Sacrifice & Tissue Analysis	
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Enzyme, plasma and urinary, electron microscopy of kidney and liver
Comments	

ANIMALS

Author	Gore, D.J. and Thorne, M.C.
Title	Proceedings to the 4th International Symposium on Inhaled Particles and Vapours, Edinburgh, pp. 22-26, September, 1975.
Publication	The Distribution and Clearance of Inhaled Uranium Dioxide Particles in the Respiratory Track of the Rat
Authors' Affiliation	M.R.C. Radiobiological Unit, Harwell
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2
Dosage/Exposure	N/A
Duration of Exposure	Single brief inhalation
Follow-up Period	N/A
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	Yes
Comments	The distribution and clearance of inhaled UO_2 particles in the respiratory tract was determined by track counting in histological sections of lung at various times. Information on this summary was obtained from the abstract only.

ANIMALS

Author	Gore, D.J.
Title	Spatial and Temporal Distribution of Inhaled Uranium Dioxide Particles in the Respiratory Track of the Rat - 2. The Relative Concentration of Uranium Dioxide Between the Intra Pulmonary Airways and the Pulmonary Tissue
Publication	Radiat. Res., 1983, Vol. 93, pp. 276-287.
Authors' Affiliation	M.R.C. Radiobiological Unit, Harwell
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Information was extracted from the abstract only (from computer literature search). The main interest was to determine the distribution of UO_2 aerosols deposited between intrapulmonary airways and pulmonary tissues.

ANIMALS

Author(s)	Heatherton, R.C., Boback, M.W. and Quigley, J.A.
Title	A Continued Program of Analysis for Uranium in Human and Animal Tissues
Publication	Proceedings of the Ninth Annual Conference on Bio-Assay and Analytical Chemistry, 10-11 October, 1963, San Diego, California
Authors' Affiliation	National Lead Company of Ohio
Subject	6 animals
Type of Exposure	Environmental
Administration	Inhalation and Ingestion (food source)
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	No
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Animals were obtained on the plant site, some found dead and some trapped alive. There were 1 rabbit, 4 muskrat and 1 opossum.

ANIMALS

Author	Hodge, H.C., Stokinger, H.E., Neuman, W.F., Bale, W.F. and Brandt, A.E.
Title	Maximum Allowable Concentration of Uranium Dust in Air
Publication	Pharmacology and Toxicology of Uranium Compounds, (ed. C. Voegtlin and H.C. Hodge), McGraw-Hill, Oxford, Chapter 26, 1953.
Authors' Affiliation	University of Rochester
Subject of Study	Rats and Dogs
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2
Dosage/Exposure	10, and 1 mg m^{-3}
Duration of Exposure	Up to 1 year
Follow-up Period	Throughout the exposure period
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	U content in bone, kidney, lung and pulmonary lymph nodes
Comments	

ANIMALS

Author(s)	Kisieleski, W.E., Faraghan, W.G., Norris, W.P. and Arnold, J.S.
Title	The Metabolism of Uranium-233 in Mice.
Publication	Journal of Pharmacology and Experimental Therapeutics, 1952, vol. 104, pp. 459-467
Authors' Affiliation	Argonne National Laboratory, Chicago
Subject	50 mice
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	Uranyl Nitrate
Dosage/Exposure	0.05 - 0.005 uc/gm body weight
Duration of Exposure	One injection
Follow-up Period	30 min - 120 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

ANIMALS

Author	LaBelle, C.W. and Brieger, H.
Title	Synergistic Effects of Aerosols - II. Effects on Rate of Clearance from the Lung.
Publication	A.M.A. Arch. Ind. Health, 1959, Vol. 20, pp. 100-105
Authors' Affiliation	Jefferson Medical College of Philadelphia
Subject of Study	20 Rats
Type of Exposure	Controlled
Administration	Intratracheal injection
Chemical Form	Activated uranium dioxide
Dosage/Exposure	20 ug and 1500 ug
Duration of Exposure	One injection
Follow-up Period	1 hr - 28 months
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes (at 24 hours and 48 hours after the injection)
Urine analysis	No
Fecal analysis	No
Other analyses	Other particulates retained in the lung
Comments	Activity counts reported but method was not specified. Carbon particles were injected to increase the lung burden to a maximum total dose of 15 mg.

ANIMALS

Author	LaBelle, C.W. and Brieger, H.
Title	Synergistic Effects of Aerosols - II. Effects on Rate of Clearance from the Lung
Publication	A.M.A. Arch. Ind. Health, 1959, Vol. 20, pp. 100-105
Authors' Affiliation	Jefferson Medical College of Philadelphia
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Intratracheal Injection
Chemical Form	N/A
Dosage/Exposure	5 ug of uranium
Duration of Exposure	One injection
Follow-up Period	At least 24 hours
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	Yes
Other analyses	No
Comments	The uranium injected was of 6um particle size. The objective was to repeat similar experiments done in 1947 (LaBelle, 1953). 1,495 ug of water insoluble dye particles were injected later on in addition to 5 ug of uranium. Activity counts were reported but the method was not specified.

ANIMALS

Author(s)	Leach, L.J., Maynard, E.A., Hodge, H.C., Scott, J.K., Yuile, C.L., Sylvester, G.E. and Wilson, H.B.
Title	A Five-Year Inhalation Study with Natural Uranium Dioxide (UO_2) Dust - I. Retention and Biologic Effect in the Monkey, Dog and Rat
Publication	Health Physics, 1970, Vol. 18, pp. 599-612
Authors' Affiliation	University of Rochester
Subject of Study	31 Monkeys, 120 dogs, 295 rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	Natural UO_2 dust
Dosage/Exposure	5 mg U/m^3
Duration of Exposure	Up to 5 years, 5 years, 1 year
Follow-up Period	No
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	UO_2 dust was inhaled 6 hr per day, 5 days per week. Some animals died during experiments and were replaced.

ANIMALS

Author(s)	Leach, L.J., Yuile, C.L., Hodge, H.C., Sylvester, G.E. and Wilson, H.B.
Title	A Five-Year Inhalation Study with Natural Uranium Dioxide (UO_2) Dust - II. Postexposure Retention and Biologic Effects in the Monkey, Dog and Rat
Publication	Health Physics, 1973, Vol. 25, pp. 239-258
Authors' Affiliation	University of Rochester
Subject of Study	38 dogs, 13 monkeys, 120 rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2 dust
Dosage/Exposure	5.8 mg/m^3 of air
Duration of Exposure	1 - 5 years
Follow-up Period	0 - 89 months (to sacrifice)
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes (5 - 6 tissues)
Urine analysis	No
Fecal analysis	No
Other analyses	Blood
Comments	6 dogs, 5 monkeys and 46 rats were for control purpose only.

ANIMALS

Author	Leach, L.J., Gelein, R.M., Panner, B.J., Yulie, C.L. and Cox, C.C.
Title	Acute Toxicity of the Hydrolysis Products of Uranium Hexafluoride (UF_6) when Inhaled by the Rat and Guinea Pig. Final Report.
Publication	Report No. K/SUB-81-9039/3
Authors' Affiliation	University of Rochester
Subject of Study	Rats and Guinea Pigs
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UF_6
Dosage/Exposure	0.44 g U/m^3 - 276.67 g U/m^3
Duration of Exposure	2, 5 or 10 minutes
Follow-up Period	14 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	The air had 0.44 g U/m^3 and 0.16 g HF/m^3 to 2.76 g U/m^3 and 94.07 g HF/m^3. The information on this summary was obtained from the abstract only.

ANIMALS

Author(s)	MacNider, W. deB.
Title	A Functional and Pathological Study of the Chronic Nephropathy Induced in the Dog by Uranium Nitrate
Publication	J. Experimental Medicine, 1919, Vol. 29, pp. 513-529
Authors' Affiliation	Laboratory of Pharmacology, University of N. Carolina
Subject to Study	27 female dogs
Type of Exposure	Controlled
Administration	Subcutaneously
Chemical Form	Uranium nitrate
Dosage/Exposure	4 mg of uranium nitrate/kg
Duration of Exposure	One dose
Follow-up Period	6 - 48 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	Content of glucose, alumin etc. in urine, blood
Comments	Animals were grouped according to age. Animals varying in age from 6 to 10.5 years were followed for 6-21 days, whereas animals of 5 to 11 months were followed for 6-48 days.

ANIMALS

Author	Maynard, E.A. and Hodge, H.C.
Title	Studies of the Toxicity of Various Uranium Compounds When Fed to Experimental Animals
Publication	Pharmacology and Toxicology of Uranium Compounds (ed. C. Voegtlin and H.C. Hodge), 1949, McGraw-Hill, Oxford, pp.309-376.
Authors' Affiliation	University of Rochester
Subject of Study	Beagle Dogs
Type of Exposure	Controlled
Administration	Oral Ingestion
Chemical Form	UO_2F_2, UO_4, UCl_4, $UO_2(NO_3)_2.6H_2O$, UO_2, $Na_2U_2O_7$ Uore, UF_4, $(NH_4)_2\ U_2O_7$ and U_3O_8
Dosage/Exposure	0-10 g/kg/day
Duration of Exposure	30 days (feeding on 6 days/week)
Follow-up Period	
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes (kidney and liver injury and gastro-intestinal hemorrhage)
Urine analysis	Yes (sugar and protein contents)
Fecal analysis	No
Other analyses	Blood (NPN and Urea N contents)
Comments	The purpose of this experiment was to determine the maximum dietary levels of various uranium compounds that can be taken for 30 days.

ANIMALS

Author	Maynard, E.A. and Hodge, H.C.
Title	Studies of the Toxicity of Various Uranium Compounds When Fed to Experimental Animals
Publication	Pharmacology and Toxicology of Uranium Compounds, (ed. C. Voegtlin and H.C. Hodge), 1949, McGraw-Hill, Oxford, pp.309-376
Authors' Affiliation	University of Rochester
Subject of Study	100 Rats (excluding 100 control rats)
Type of Exposure	Controlled
Administration	Oral ingestion
Chemical Form	$UO_2(NO_3)_2.6H_2O$, UO_2F_2, UF_4 and UO_2
Dosage/Exposure	0-20% in the diet
Duration of Exposure	Up to 2 years
Follow-up Period	Through the program
In Vivo Measurement	No
Sacrifice and Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	Yes
Comments	The results were part of a feeding experiment where growth depression, mortality, toxicity, number of matings etc. were observed.

ANIMALS

Author	Maynard, E.A. and Hodge, H.C.
Title	Studies of the Toxicity of Various Uranium Compounds When Fed to Experimental Animals
Publication	Pharmacology and Toxicology of Uranium Compounds (ed. C. Voegtlin and H.C. Hodge), 1949, McGraw-Hill, Oxford, pp. 309-376
Authors' Affiliation	University of Rochester
Subject of Study	2713 Rats (excluding 1916 control rats)
Type of Exposure	Controlled
Administration	Oral Ingestion
Chemical Form	UO_2F_2, $UO_2(NO_3)_2.6H_2O$, UCl_4, UF_4, UO_2, UO_4, U_3O_8, UO_3 or UO_2Ac_2
Dosage/Exposure	0, 0.5, 2 or 20% of the diet
Duration of Exposure	30 days
Follow-up Period	Followed through the feeding period - 30 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	Blood counts
Comments	The aim was to classify the toxicity of various uranium compounds and their lethal levels in diets. Growth effect and mortality were reported for each compound at each level.

ANIMALS

Author(s)	Morrow, P.E., Gibb, F.R. and Johnson, L.
Title	Clearance of Insoluble Dust from the Lower Respiratory Tract
Publication	Health Physics, 1964, Vol. 10, pp. 543-555
Authors' Affiliation	University of Rochester
Subject to Study	Female beagle dogs
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	Uranium dioxide (enriched)
Dosage/Exposure	240 $\pm$ 80 ug/L
Duration of Exposure	30 - 90 minutes
Follow-up Period	Up to 4 weeks
In Vivo Measurement	Yes
Sacrifice & Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Blood
Comments	Clearance rate of inhaled aerosols from the lower respiratory track studied.

ANIMALS

Author(s)	Morrow, P.E., Gibb, F.R. and Leach, L.J.
Title	The Clearance of Uranium Dioxide Dust from the Lungs Following Single and Multiple Inhalation Exposures
Publication	Health Physics, 1966, Vol. 12, pp. 1217-1223
Authors' Affiliation	University of Rochester
Subject to Study	32 dogs, 160 rats, 16 monkeys
Type of Exposure	Controlled
Administration	Inhalation (nose only)
Chemical Form	$^{238}UO_2$
Dosage/Exposure	6 mg/m^3 of air
Duration of Exposure	5 Years, 1 year, 5 years
Follow-up Period	800 days, 380 days, 350 days
In Vivo Measurement	Yes
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Multiple exposures. Animals were exposed 6 hr/day, 5 days a week for the period indicated above.

ANIMALS

Author(s)	Morrow, P.E., Gibb F.R. and Leach, L.J.
Title	The Clearance of Uranium Dioxide Dust from the Lungs Following Single and Multiple Inhalation Exposures
Publication	Health Physics, 1966, Vol. 12, pp. 1217-1223
Authors' Affiliation	University of Rochester
Subject of Study	Dogs
Type of Exposure	Controlled
Administration	Inhalation (nose only)
Chemical Form	$^{235}UO_2$
Dosage/Exposure	240 mg/m^3 of air
Duration of Exposure	0.8 hour
Follow-up Period	N/A
In Vivo Measurement	Yes
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Single exposure.

ANIMALS

Author(s)	Morrow, P.E., Gibb, F.R. and Beiter, H.D.
Title	Inhalation Studies of Uranium Trioxide
Publication	Health Physics, 1972, Vol. 23, pp. 273-280
Authors' Affiliation	University of Rochester
Subject of Study	4 Beagle dogs
Type of Exposure	Controlled
Administration	Inhalation (nose only)
Chemical Form	UO_3 (enriched)
Dosage/Exposure	$8 \pm 2 \times 10^{-3}$ uCi/L
Duration of Exposure	2 - 4 hours (over a period of 2-5 days)
Follow-up Period	26 - 218 days (to sacrifice)
In Vivo Measurement	Thorax
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	

ANIMALS

Author	Morrow, P.E., Leach, L.J., Smith, F.A., Gelin, R.A. and Scott, J.B.
Title	Acute Effects of Inhalation Exposure to Uranium Hexafluoride and Patterns of Deposition: UF_6/UO_2F_2 Studies in Experimental Animals
Publication	NRC Research Report, 1980
Authors' Affiliation	University of Rochester
Subject of Study	Dogs and Rats
Type of Exposure	Controlled
Administration	Inhalation, Intratracheal Installation and Intravenous Injection
Chemical Form	UF_6/UO_2F_2
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Final report in Morrow et al., 1982. The content of this summary was obtained from the abstract only.

ANIMALS

Author	Morrow, P.E., Leach, L.J., Smith, F.A., Gelein, R.M. and Scott, J.B.
Title	Metabolic Fate and Evaluation of Injury in Rats and Dogs Following Exposure to the Hydrolysis Products of Uranium Hexafluoride. Implication for a Bioassay Program Related to Potential Release of Uranium Hexafluoride
Publication	NRC Research Report, 1982
Authors' Affiliation	University of Rochester
Subject of Study	Rats and Dogs
Type of Exposure	Controlled
Administration	Inhalation, intratracheal installation and parenteral injection
Chemical Form	Spontaneous hydrolysis products of UF_6
Dosage/Exposure	N/A
Duration of Exposure	Single - multiple exposures
Follow-up Period	N/A
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Special attention was given to the dose-effect relationships appropriate to the kidney. Content of this summary was obtained from the abstract only.

ANIMALS

Author(s)	Morrow, P., Gelein, R., Beiter, H., Scott, J., Picano J. and Yuile, C.
Title	Inhalation and Intravenous Studies of UF_6/UO_2F_2 in Dogs
Publication	Health Physics, 1982, Vol. 43, pp. 859-873
Authors' Affiliation	University of Rochester
Subject of Study	5 Beagle dogs
Type of Exposure	Controlled
Administration	Intravenous injection
Chemical Form	UO_2F_2
Dosage/Exposure	< 1 ml of 1 % UO_2F_2 solution
Duration of Exposure	1 injection
Follow-up Period	26 hours - 14 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Cage water
Comments	

ANIMALS

Author(s)	Morrow, P., Gelein, R., Beiter, H., Scott, J., Picano J. and Yuile, C.
Title	Inhalation and Intravenous Studies of UF_6/UO_2F_2 in Dogs
Publication	Health Physics, 1982, Vol. 43, pp. 859-873
Authors' Affiliation	University of Rochester
Subject of Study	19 Beagle dogs
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UF_6 and UO_2F_2
Dosage/Exposure	250 - 270 mg/m^3 of UO_2F_2
Duration of Exposure	30 min to 2.5 hour
Follow-up Period	hours - 19 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Cage water
Comments	

ANIMALS

Author(s)	Neuman, W.F., Neuman, M.W. and Mulryan, B.J.
Title	The Deposition of Uranium in Bone - I. Animal Studies
Publication	J.Bio. Chem., 1948, Vol. 175, pp. 705-709
Authors' Affiliation	University of Rochester
Subject	95 Rats
Type of Exposure	Controlled
Administration	Intraperitoneal injection
Chemical Form	Uranyl nitrate or acetate
Dosage/Exposure	2.5 mg/kg of body weight
Duration of Exposure	One injection
Follow-up Period	48 hours
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	Bones and teeth
Comments	

ANIMALS

Author(s)	Neuman, W.F., Fleming, R.W., Dounce, A.L., Carlson, AB., O'Leary, J. and Mulryan, B.
Title	The Distribution and Excretion of Injected Uranium
Publication	J. Bio. Chem., 1948, Vol. 173, pp. 737-748
Authors' Affiliation	University of Rochester
Subject	Rats
Type of Exposure	Controlled
Administration	Intravenous injection
Chemical Form	Uranyl nitrate
Dosage/Exposure	2.5 mg of U/kg of body weight
Duration of Exposure	One injection
Follow-up Period	45 minutes - 44 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Hair
Comments	

ANIMALS

Author(s)	Neuman, M.W. and Neuman, W.F.
Title	The Deposition of Uranium in Bone - II. Radioautographic Studies
Publication	J. Bio. Chem., 1948, Vol. 175, pp. 711-714
Authors' Affiliation	University of Rochester
Subject	4 Rats
Type of Exposure	Controlled
Administration	Intraperitoneal injection
Chemical Form	Uranyl nitrate
Dosage/Exposure	1.5 - 3.0 mg U/kg
Duration of Exposure	One injection
Follow-up Period	4 hr - 40 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Emphasis was placed on deposition of uranium in bones.

ANIMALS

Author	Price, G.R.,Ferretti, R.J. and Schwartz, S.
Title	The Micro-fluorometric Determination of Uranium
Publication	Toxicology of Uranium (ed. A. Tannenbaum), 1951, McGraw-Hill, New York
Authors' Affiliation	Metallurgical Laboratory
Subject of Study	Rabbits
Type of Exposure	Controlled
Administration	Subcutaneous Injection
Chemical Form	Uranyl Nitrate
Dosage/Exposure	Non-toxic Amount
Duration of Exposure	One injection
Follow-up Period	5 days - 21 months
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes (12 tissues analyzed)
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

ANIMALS

Author	Price, G.R., Ferretti, R.J. and Schwartz, S.
Title	Toxicology of Uranium, (ed. A. Tannenbaum), 1951, McGraw-Hill, New York
Publication	The Micro-fluorometric Determination of Uranium
Authors' Affiliation	Metallurgical Laboratory
Subject of Study	Dogs, Mice and Rats
Type of Exposure	Controlled
Administration	Subcutaneous Injection
Chemical Form	Uranyl Nitrate
Dosage/Exposure	N/A
Duration of Exposure	Single Injection
Follow-up Period	One week - 6 weeks
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No

Comments

ANIMALS

Author	Priest, N.D., Howells, G.R., Green, D. and Haines, J.W.
Title	Hum. Toxicol., 1982, Vol. 1, pp. 97-114
Publication	Uranium in Bone: Metabolic and Autoradiographic Studies in Rats
Authors' Affiliation	N/A
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	Hexavalent Uranium-233
Dosage/Exposure	N/A
Duration of Exposure	One injection
Follow-up Period	At least 40 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	Yes
Comments	Analyses were performed using a variety of autoradiographic and radiochemical techniques to trace the uranium in rats. The information in this summary was obtained from the abstract only.

ANIMALS

Author(s)	Rowland, R.E. and Farnham, J.E.
Title	The Deposition of Uranium in Bone
Publication	Health Physics, 1969, Vol. 17, pp. 139-144
Authors' Affiliation	Argonne National Laboratory
Subject	4 Beagle dogs
Type of Exposure	Controlled
Administration	Intravenous injection
Chemical Form	Uranyl nitrate
Dosage/Exposure	25 - 200 uCi of uranium
Duration of Exposure	One injection
Follow-up Period	2 - 72 days
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	Bone analysis, blood in vitro analysis

Comments

ANIMALS

Author	Sontag, W.
Title	The Early Distribution of 239-Pu, 241-Am, and 233-U in the Soft Tissues and Skeleton of Old Rats - A Comparative Study
Publication	Hum. Toxicol., 1983, Vol. 2, pp. 91-100
Authors' Affiliation	Federal Republic of Germany
Subject of Study	2 Rats
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	233-U - Citrate
Dosage/Exposure	1.53 muCi/kg (see comments)
Duration of Exposure	Single Injection
Follow-up Period	7 and 28 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Information on this summary was obtained from the abstract only. muCi/kg reported in abstract assumed to be nCi/kg by SENES.

ANIMALS

Author	Sontag, W.
Title	Long-Term Behavior of 239-Pu, 241-Am, and 233-U in Different Bones of One-Year-Old Rats: Macrodistribution and Macrodosimetry
Publication	Hum. Toxicol., 1984, Vol. 3, pp. 469-483
Authors' Affiliation	Institut fuer Genetik und fuer Toxikologic von Spaltstoffen, Federal Republic of Germany
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	233-U-citrate
Dosage/Exposure	56.6 kBq/kg
Duration of Exposure	Single injection
Follow-up Period	7-540 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Radionuclides remaining in the skeleton were examined. The information in this summary was obtained from the abstract only.

ANIMALS

Author(s)	Stanley, J.A., Edison, A.F. and Mewhinney, J.A.
Title	Distribution, Retention and Dosimetry of Plutonium and Americium in the Rat, Dog and Monkey after Inhalation of an Industrial Mixed Uranium and Plutonium Oxide Aerosol.
Publication	Health Physics, 1983, Vol. 43, pp. 521-530
Authors' Affiliation	Inhalation Toxicology Research Institute Lovelace Biomedical and Environmental Research Institute
Subject	36 rats, 18 beagles, 9 monkeys
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2 and PuO_2 aerosols
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	4 hours - 2 years
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	

ANIMALS

Author	Stevens, W., Bruenger, F.W., Atherton, D.R., Smith, J.M. and Taylor, G.N.
Title	The Distribution and Retention of Hexavalent Uranium-233 in the Beagle
Publication	Radiat. Res., 1980, Vol. 83, pp. 109-125
Authors' Affiliation	University of Utah
Subject of Study	7 Beagles
Type of Exposure	Controlled
Administration	Intravenous Injection
Chemical Form	Uranium-233 in citrate buffer
Dosage/Exposure	2.8 mu.Ci 233 U (VI)/kg (approx. 3 mg/dog)
Duration of Exposure	One injection
Follow-up Period	1 - 726 days post injection
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Information extracted from the abstract only (from computer literature search). muCi/kg reported in abstract - assumed to be nCi/kg by SENES.

ANIMALS

Author(s)	Stokinger, H.E., Steadman, L.T., Wilson, H.B., Sylvester, G.E., Dziuba, G.E. and LaBelle, C.W.
Title	Lung Deposition and Retention of Inhaled Insoluble Particulates
Publication	Arch. Industr. Hyg., 1951, Vol. 4, pp. 346-353
Authors' Affiliation	University of Rochester
Subject	50 Rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	U_3O_8 and UO_2
Dosage/Exposure	68 mg U/m^3 and 71 mg U/m^3
Duration of Exposure	6 hours and 54 hours
Follow-up Period	20 hours - 8 months
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	A group of 10 rats was exposed to each condition (1.68 mg U/m^3 of U_3O_8 for 6 hours, 2.68 mg U/m^3 of U_3O_8 for 54 hours, 3.71 mg U/m^3 of UO_2 for 6 hours, and 4.71 mg U/m^3 of UO_2 for 54 hours. Another 10 were controls. The 54-hour exposure groups were exposed for 6 hours a day (9 days) during an 11-day calendar period).

ANIMALS

Author(s)	Stradling, G.N., Smith, H., Cooper, J.R., Ham, S.E., Cooke, N., Sedgwick, D. and Shaw, R.S.T.
Title	Factors Affecting the Abundance of Uranium Isotopes in Body Tissues and Excreta Following the Deposition of Enriched Uranium Dioxide in the Lungs - The Radiological Implications
Publication	Health Physics, 1984, Vol. 46, pp. 434-438
Authors' Affiliation	British Nuclear Fuels Limited and National Radiological Protection Board
Subject	30 Hamsters
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	hours - 53 weeks (to sacrifice)
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Aerosols contained 2.55% ^{235}U

ANIMALS

Author	Stradling, G.N., Stather, J.N., Strong, J.C.,Summer, S.A., Towndrow, C.G., Moody, J.C., Lennox, A., Sedgwick, D. and Cooke, N.
Title	Metabolism of Some Industrial Uranium Tetrafluoride After Deposition in the Rat Lung
Publication	Hum. Toxicol., 1985, Vol. 4, pp. 159-163
Authors' Affiliation	National Radiological Protection Board, UK
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Inhalation or Direct Injection into the Lungs
Chemical Form	2 commercially produced natural uranium tetrafluorides
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Information of this summary was obtained from the abstract only.

ANIMALS

Author	Stradling, G.N., Stather, J.W., Ellander, M., Sumner, S.A., Moody, J.C., Towndrow, C.G.Hodgson, A., Sedgewick, D. and Cooke, N.
Title	Metabolism of an Industrial Uranium Trioxide Dust After Deposition in the Rat Lung
Publication	Human Toxicology, 1985, Vol. 4, pp. 563-572
Authors' Affiliation	National Radiological Protection Board, UK
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Inhalation or direct injection of an aqueous suspension into the Lungs
Chemical Form	Uranium Trioxide
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Yes
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	Information obtained from the abstract only.

ANIMALS

Author	Tannenbaum, A. and Silverstone, H.
Title	Accumulation of Uranium in the Tissues of Mice Ingesting Uranyl Nitrate
Publication	Toxicology of Uranium (ed. A. Tannenbaum), 1951, McGraw-Hill, New York, pp. 105-108
Authors' Affiliation	Michael Reese Hospital
Subject of Study	Mice
Type of Exposure	Controlled
Administration	Oral Ingestion
Chemical Form	N/A
Dosage/Exposure	80 mg of uranium
Duration of Exposure	20 weeks
Follow-up Period	Additional 16 days post exposure
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Information on this summary was obtained from the abstract only.

ANIMALS

Author	Tannenbaum, A. and Silverstone, H.
Title	Accumulation of Uranium in the Tissues of Mice Ingesting Uranyl Nitrate.
Publication	Toxicology of Uranium, (ed. A. Tannenbaum), 1951, McGraw-Hill, New York, pp. 105-108
Authors' Affiliation	Metallurgical Laboratory
Subject of Study	Mice
Type of Exposure	Controlled
Administration	Oral Ingestion
Chemical Form	Uranyl Nitrate
Dosage/Exposure	20 mg of uranium nitrate/day
Duration of Exposure	Up to 95 weeks
Follow-up Period	Throughout the exposure period
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Experiment 14

ANIMALS

Author	Tannenbaum, A. and Silverstone, H.
Title	Accumulation of Uranium in the Tissues of Mice Ingesting Uranyl Nitrate
Publication	Toxicology of Uranium, (ed. A. Tannenbaum), 1951, McGraw-Hill, New York, pp. 105-108
Authors' Affiliation	Michael Reese Hospital
Subject of Study	Mice
Type of Exposure	
Administration	Subcutaneous Injection
Chemical Form	Uranium Nitrate
Dosage/Exposure	2 mg
Duration of Exposure	Single injection
Follow-up Period	45 - 287 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Information on this summary was obtained from the abstract only.

ANIMALS

Author	Tannenbaum, A. and Silverstone, H.
Title	Accumulation of Uranium in the Tissues of Mice Ingesting Uranyl Nitrate
Publication	Toxicology of Uranium, (ed. A. Tannenbaum), 19051, McGraw-Hill, New York, pp.105-108
Authors' Affiliation	Metallurgical Laboratory
Subject of Study	29 Mice
Type of Exposure	Controlled
Administration	Oral Ingestion
Chemical Form	Uranyl Nitrate
Dosage/Exposure	48 of 1.1% uranyl nitrate hexahydrate diet daily
Duration of Exposure	Up to 70 weeks
Follow-up Period	Through exposure period only
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes (at selected intervals)
Urine analysis	No
Fecal analysis	No
Other analyses	Growth
Comments	Experiment M146

ANIMALS

Author	Tannenbaum, A., Silverstone, H. and Koziol, J.
Title	Distribution of U-233 in Tissues of Mice Following Injection of Uranyl Nitrate
Publication	Toxicology of Uranium (ed. A. Tannenbaum), 1951, McGraw-Hill, New York, pp. 124-127
Authors' Affiliation	Metallurgical Laboratory
Subject of Study	Mice
Type of Exposure	Controlled
Administration	Subcutaneous or Intramuscular Injection
Chemical Form	Uranyl Nitrate Hexahydrate
Dosage/Exposure	1.5, 15 or 45 ug
Duration of Exposure	One injection
Follow-up Period	2 weeks or 4 weeks after injection
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	^{233}U was used.

ANIMALS

Author	Tannenbaum, A., Silverstone, H. and Koziol, J.
Title	Distribution of U-233 in Tissues of Mice Following Injection of Uranyl Nitrate
Publication	Toxicology of Uranium (ed. A. Tannenbaum), 1951, McGraw-Hill, New York, pp. 124-127
Authors' Affiliation	Michael Reese Hospital, Chicago
Subject of Study	Mice, Rats and Dogs
Type of Exposure	Controlled
Administration	Injection
Chemical Form	Uranyl Nitrate
Dosage/Exposure	N/A
Duration of Exposure	One injection
Follow-up Period	At least one month
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Radioautographs
Comments	Highly radioactive isotopes of uranium were used either as tracers or alone. Information was obtained from the abstract only.

ANIMALS

Author(s)	Walinder, G., Fries, B. and Billaudelle, U.
Title	Incorporation of Uranium - II. Distribution of Uranium Absorbed Through the Lungs and the Skin
Publication	Brit. J. Ind. Med., 1967, Vol. 24, pp. 313-319
Authors' Affiliation	Surgery Department II, Sabbatsbergs Sjukhus Stockholm
Subject	13 Rabbits, 2 piglets
Type of Exposure	Controlled
Administration	Subcutaneously in an incision
Chemical Form	U_3O_8
Dosage/Exposure	20 - 37 mg for rabbits, 200 mg for piglets
Duration of Exposure	One dose
Follow-up Period	One week
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	6 in 13 rabbits and 1 piglet were injected 5 - 10 mg of polyphloretin phosphate into the the subcutaneous pocket immediately after closure of the wound.

ANIMALS

Author(s)	Walinder, G., Fries, B., and Billaudelle, U.
Title	Incorporation of Uranium - II. Distribution of Uranium Absorbed Through the Lungs and the Skin
Publication	Brit. J. Ind. Med., 1967, Vol. 24, pp. 313-319
Authors' Affiliation	Surgery Department II, Sabbatsbergs Sjukhus Stockholm
Subject	4 Rabbits
Type of Exposure	Controlled
Administration	Applied to surface abrasions
Chemical Form	U_3O_8 (natural) or Uranyl acetate
Dosage/Exposure	70 mg of U_3O_8 or 0.05 uCi uranyl acetate (5 ug U)
Duration of Exposure	One dose
Follow-up Period	N/A
In Vivo Measurement	No
Sacrifice & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	No
Other analyses	No
Comments	2 rabbits were soaked in polyphloretin phosphate immediately after the application of uranium.

ANIMALS

Author(s)	Walinder, G., Fries, B., and Billaudelle, U.
Title	Incorporation of Uranium - II. Distribution of Uranium Absorbed through the Lungs and the Skin
Publication	Brit. J. Ind. Med., 1967, Vol. 24, pp. 313-319
Authors' Affiliation	Surgery Department II, Sabbatsbergs Sjukhus, Stockholm
Subject	Mice
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	Uranium oxide aerosols
Dosage/Exposure	$(8 - 9) \times 10^{-3}$ ug/cm^3 air
Duration of Exposure	N/A
Follow-up Period	60 days
In Vivo Measurement	No
Sacrificie & Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Air was passed through a water suspension of U_3O_8 particles to produce hydrosol-contained particles of uranium. The hydrosols were then converted to uranium oxide by heating and drying.

ANIMALS

Author	Walinder, G., Hammarstrong, L. and Billaudelle, U.
Title	Incorporation of Uranium - I. Distribution of Intravenously and Intraperitoneally Injected Uranium
Publication	Brit. J. Industr. Med., 1967, Vol. 24, pp. 305-312
Authors' Affiliation	Surgery Department II, Sabbatsbergs Sjuknus, Stockholm
Subject of Study	7 Mice
Type of Exposure	Intravenous Injection (into a tail vein)
Administration	
Chemical Form	Uranyl tricarbonate (233U)
Dosage/Exposure	42 ug uranium
Duration of Exposure	One injection
Follow-up Period	24 hours - 6 months
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Analyses of uranium distribution in various organs and tissues were studied by autoradiographic and fluorometric methods.

ANIMALS

Author	Walinder, E., Hammarstrom, C. and Billandelle, U.
Title	Incorporation of Uranium - I. Distribution of Intravenously and Intraperitoneally Injected Uranium
Publication	Brit. J. Industr. Med., 1967, Vol. 24, pp. 305-312
Authors' Affiliation	Surgery Department II, Sabbatsbergs Sjukhus, Stockholm
Subject of Study	75 mice, 2 piglets
Type of Exposure	Controlled
Administration	Intraperitoneal or Intravenous injection
Chemical Form	Uranyl tricarbonate or uranyl nitrate
Dosage/Exposure	Equivalent to 30 ug/mouse and 180 ug/pig of natural uranium
Duration of Exposure	One injection
Follow-up Period	1 day - 217 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Both piglets received uranyl tricarbonate injected into an ear vein.

ANIMALS

Author	Wilson, M.B., Sylvester, G.E., Laskin, S., LaBelle, C.W., Scott, J.K. and Stokinger, H.E.
Title	Relation of Particle Size of Uranium Dioxide Dust to Toxicity Following Inhalation by Animals: II
Publication	A.M.A. Arch. Industr. Hyg. and Occup. Med., 1952, Vol. 6, pp. 93-104
Authors' Affiliation	University of Rochester
Subject of Study	32 Rabbits and 46 Rats
Type of Exposure	Controlled
Administration	Inhalation
Chemical Form	UO_2
Dosage/Exposure	76 mg/m^3 or 83 mg/m^3 air
Duration of Exposure	192 hours
Follow-up Period	6 - 20 days
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes
Urine analysis	Yes (analyzed for protein, amino-acid nitrogen and creatimine)
Fecal analysis	No
Other analyses	Body weight, lung weight and lung damage
Comments	192 exposure hours were on 29 exposure days, over a period of 37 calendar days. 2 particle sizes of UO_2 dust were used: > 1 u and 0.5 u.

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